SOME COMMENSALS OF INDIAN ALCYONARIANS AND CRABS.

By

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(*With 6 text figures.*)

No group of marine animals is more prone than the Alcyonarians to harbour uninvited guests, often of very varied zoological standing. Indian Alcyonarians or 'Soft Corals' as we may dub them in common parlance, are exceedingly variable in form, ranging from the brick red Sea-whip, *Juncella juncea*, through the great assemblage of the Sea-fans, the Gorgonids proper, to the massive Sea-cauliflowers of which *Spongodes* is the type; besides these are the Sea-pens—the thin starved rods of *Virgularia*, the pinnate fleshy *Pennatula*, typical of the group, and the great soft obese *Cavernularia* that lives gregarious in muddy sand.

Those that are greatly branched, offer the best shelter to small animals looking for safe hiding places and so it happens that Spongodes and its near relatives harbour a greater variety of commensals* than any other marine organism.

The Commensals of Spongodes.—The common form of Spongodes met with in Indian seas lives from low tide level (Gulf of Kutch) to depths of about 10 fathoms. It is particularly common in 5 to 8 fathoms in the Pearl Bank region of the Gulf of Mannar; the dredge and the divers bring it up in dozens when the right spot, fairly clean sandy ground, is met with. The term sea-cauliflower which, for want of any accepted English name, is what I propose to call it, gives an accurate idea of the general appearance of a well-grown typical colony, if we imagine all the outer leaves torn away and the terminal florets tinted some bright colour from yellow and orange to pink and dark lake. Each colony has a short massive stalk or rather trunk, giving off numerous branches which divide and subdivide till the terminal branchlets are reached, on which are set innumerable little polyps, white or lemon tinted, each protected by a collar of defensive coloured spicules. The whole is rooted in the sand by means of many sand-encrusted 'rootlets'. The substance of the trunk and branches is permeated by a system of numerous wide canals and by means either of flooding or partially draining these by the action of a net-work of fine muscles fibres, the colony is capable of assuming very different forms; it may expand freely, spreading wide and loosely its many branches—its normal condition—or it may retract into a compact nearly solid mass if irritated, with every gradation between the two extremes. Preserved specimens exhibit many of these gradations, dependent upon the method of killing and the time that has elapsed between capture and preservation. This, in conjunction with the natural great variability of the common species, has landed systematists in difficulties. On the one hand we have lists of 80 or more species, and on the other, the opinion of such an able zoologist as Prof. Sydney J. Hickson, that possibly there is only one true species to which all the 80 may be referred.

The commonest form of Spongodes on our pearl banks is one where the terminal branchlets are suffused some tint of red, usually a warm dark pink, the trunk (excepting the base which is dirty grey) and the main branches being white. This form approaches most closely to the species (? varieties) described by Prof. J. A. Thompson under the names *Spongodes bicolor* and *S. pulchra*.

If specimens of this species be examined as soon as they are brought up by the dredge or by divers, a host of symbiotic animals can be located hiding among

* To be strictly accurate, I ought to say symbiotic organisms, for the term commensals should be restricted to animals that live together in partnership and share the same table. But in this paper I use it in a somewhat loose way as a convenient word to cover all animals that lodge with another and are not definitely parasitic.

the branches; the list includes at least a couple of brittle-stars, several crustaceans including a galatheid, a porcelain-crab, a clicking prawn, a colourless compound ascidian and a tiny little cowry. A sipunculid worm is often present among the anchoring rootlets, while last and most interesting is one of the velvet-crabs, belonging to the family *Dromiidæ*.

Omitting the last two, the others with the one exception of the alpheid, have the body ordinarily speckled, spotted or mottled with some tint of red.

The most numerous of these uninvited guests is the little porcelain-crab, *Porcellana quadrilobata*. Several of these are usually met with in each colony, the younger and smaller either colourless (white) or faintly speckled with red, while the larger generally have the carapace well mottled with pink. Both colourations are protective as the white ones harmonize with the colour of the trunk and branches, while the pink-mottled are easily lost to sight amongst the pinktipped branchlets. The graceful Galatheid, *Polyonyx biunguiculatus*, is also sometimes found, its upper surface mottled reddish brown. The Ophiuroid and the Cowry are still more distinctively blotched with red, and both seem to be consistently associated with this particular species of Spongodes for I have never seen them elsewhere. They are not however always present and they seem local in occurrence. For example, out of 14 spongodes examined on one occasion on the Ceylon banks, 10 had this ophiuroid, while of 12 examined a few days later from the same depth of water (5 to 6 fathoms) but from a locality a few miles distant, in no case was this ophiuroid seen. It is a smooth-armed species of fair size; the disc measures 10mm. across, the arms $3\frac{1}{2}$ to $4\frac{1}{2}$ inches in length. It lies securely lodged among the branches, the long arms twining ivy-like in and out among them. In colour it is whitish, with five groups of pinkish red blotches on the aboral surface of the disc, and with band-like splashes of the same colour at regular intervals on the upper surface of the arms. The under surface is uniformly white. The upper surface of the arms is actually in no place quite without red pigment; tiny points of red occur over the whole surface, but at fairly evenly spaced intervals they are greatly increased in number and this massing gives rise to the appearance so characteristic of this species of having the arms regularly banded with pinkish red. In some individuals the general pigmentation is much more intense than in others but it can be made out in all when they are carefully examined. When moving about over the host's branches this scheme of colouring harmonizes effectively with the pink and white of the terminal polyp-bearing twigs.

The last of the commensal crustaceans, the clicking-prawn, *Synalpheus gravieri*, never exhibits any red spotting. This is no disadvantage to it, for it is too large, active and pugnacious to fear any animal that is small enough or brave enough to penetrate within the spicule-beset branches of the host. In any case its pale white tint does agree with that of the inner recesses of Spongodes.

Then there is the tiny little spotted Cowry (*Cypraea*). It lives among the outer branches where there is a good deal of mottled reddish colouring. Its mantle, normally reflected over the whole of the shell, is accordingly spotted red, harmonizing exactly with the red and white mottling of its host. The shell itself is marked with a few large brown blotches, quite different from the numerous small red spots on the mantle; as the latter enwraps the shell completely, the colouring shown to the world of its enemies is that of the mantle.

Normally the trunk of this species of Spongodes is entire and solid looking, but a considerable proportion of large-sized individuals from one particular area of the Ceylon Pearl Banks, namely the sandy ground to the east of the Cheval Pār and around the Moderagam Pārs, where it is particularly abundant, have either deep pockets in the upper part of the trunk, or have wide tubes passing down this main axis. These cavities do not communicate in any way with the intrinsic canal system of the Alcyonarian. In many instances the open central

tube passes completely to the base of the colony, with an opening to the sand beneath, situated more or less centrally among the "rootlets". The upper end communicates with the exterior usually by a simple wide opening, occasionally by two. Such apertures occur on the side of the trunk towards its summit, well concealed by the bases of the main branches which spring from this region.

When the Spongodes colonies have lain about for some time after collection, the 'pockets' and tubes are found empty; when examined immediately the divers bring them up, a small rounded crab, a *Dromia*, an inch to an inch and a half across the carapace, covered with a velvety coating of short golden brown hairs, is found lodging in many—not in all, for this Dromia can be active at times when danger is apprehended and in the cases where his tube has an opening to the sand beneath, he sometimes has time to slip down and shake himself free of the colony as this is being drawn by the diver from its attachment in the sand. His smooth velvet coat facilitates this escape through the lower opening of the burrow. One Dromia only is found in each Spongodes colony. Fragments of Spongodes branchlets, bearing polyps and having every appearance of having been nipped off recently, are frequently present in the tubular burrow, giving rise to the inference that Dromia uses his host's body not only as a dwelling place, but also as a constantly renewed larder; in such case the intruder comes really within the definition of parasite rather than commensal. Very often the walls of the tubular pocket or tube wherein the crab lives, is tinted a distinct red. At first I took this for a development of red spicules in the walls, due perhaps to special irritation, but closer examination proved it to be owing to the presence of more or less broken spicules lying loose in a mucous layer on the inner surface of the tube. It is probable then that these broken spicules are detritus from the food consumed by the crab. Quite frequently the scars where branchlets have been nipped off, can be seen on the surface of these crab-frequented Spongodes.

As showing the great frequency of this peculiar association, on one day out of twelve Spongodes colonies obtained from the Kallatidal Pār (Ceylon Pearl Banks) from a depth of 5 to 5½ fathoms, five contained these symbiotic crabs, lodged in tubular cavities excavated in the trunk. In three instances the cavity went right through the base and opened among the rootlets. In the other two it went far down the trunk, but did not perforate the base. The upper aperture of the tube was usually close to the summit of the main axis but to one side; in one case two apertures were present close to the top, while in another the opening was only about half way up the trunk. My observations convince me that these cavities are induced by the crab, but whether they are formed by the crab forcing its way in by continued and persistent pressure or whether they are produced by the tissues of the *Spongodes* colony gradually growing upwards and around the crab, we cannot as yet say. It is a well-known habit of many species of Dromia to detach fragments of sponges and compound ascidians from their original attachment, and to hold the fragment over the carapace with the aid of the specially modified hinder thoracic legs until such time as the fragment has grown and shaped itself on the under side, exactly to the convexity of the crab's carapace. How this habit has been modified in the case of Spongodes has yet to be discovered but I am inclined to think that the association is formed early in the life of both organisms, and that from a small depression in which the crab first lodged for safety, the subsequent change to a long wide tube is due to the continued presence of the crab necessitating the axis to grow upwards as a hollow cylinder instead of a solid one. I do not consider it to be a gall-like growth but merely an aperture in the tissues kept open by the mechanical presence, not necessarily causing irritation, of the intruding crustacean. Possibly however the crab may help mechanically in the formation of the burrow by pinching and pulling the tissues.

In species of Spongodes of more lax growth such as *S. dendrophyta*, where the stem is markedly elongated, I have never found Dromia present. The habit of such species would appear to make it less fitted for concealment than in *Spongodes pulchra*; the association also appears local in its range, for while common over a considerable area off the Ceylon coast in the pearl bank region, I have never found it to occur on the Indian side, where the same species of Spongodes is equally abundant.

The Commensals of Solenocaulon tortuosum, Gray.—This species is common in depths of 8 to 9 fathoms on certain coarse sandy ground off Tuticorin, particularly in the vicinity of the pearl bank known as the Melonbadu Pār. It is perhaps the most handsome of Indian Alcyonarians, consisting of a strong stalk rooted at its base in the sand, the projecting part a foot and even more in length, the whole suffused with shades of pinkish red. Frequently the stalk, at a height of a few inches above the ground, divides into two main branches, broad and foliaceous in appearance, giving off again secondary branches even more foliaceous, which in turn give off numerous stout terminal branchlets, bearing most elegant yellow tinted polyps. The stalk except at the base is usually tubular, as are also usually the primary branches. The secondary branches may be either tubular or merely grooved. Variation in form is however extreme and all possible modifications may be met with both in branching and in the extent of tubulation. In some, the tubular character is even restricted to the stalk; in others it extends only into the primary branches, the remainder being grooved in varying degree from a slight inturning of the margin to a deep semi-circular gutter. On account of this great variation Prof. S. J. Hickson* united all the previously described species into one, and I consider he is correct in this attitude. He was also the first to put forward the theory that the origin of the tubulation of the stalk and branches is due to the constant irritation caused to the tissues by the running backwards and forwards of symbiotic crustaceans belonging to the genus *Alpheus*. Hickson notices the presence of these little prawns in the tubular portions of many of the preserved specimens from the Maldives which came under his examination. He hazarded the suggestion that the tubular character of *Solenocaulon* is "of the nature of a gall produced by an active crustacean and that the degree to which it affects the secondary and tertiary branches depends, not upon any inherent specific character of the *Solenocaulon*, but upon the number or activity of the symbiotic crustacea." He instanced the well-known fact that in such corals as *Pocillopora*, *Seriatopora*, and *Millepora*, which often harbour a symbiotic crab, its presence affects growth at the place where it settles and there induces the formation of a spherical or oval gall, "the margins of the affected part being hypertrophied and growing round and enclosing the animal that causes the irritation"; analogous gall-like growths are produced on the branches of various corals and gorgonids by the settlement thereon of various species of cirripedes, whose presence causes a local disturbance of normal growth. He pointed out also how the hypertrophied surfaces in such cases show a smoothness of surface, and in Millepora, an absence of polyps of the same character as is exhibited by the grooved surfaces of the branches and terminal twigs of Solenocaulon. The new evidence which I have adduced above showing how similar and even greater tubes are formed in the related genus of *Spongodes*, goes far to prove the validity of his main inference. My observations show however that other animals live symbiotic lives with Solenocaulon, besides the Alpheid mentioned by Hickson. The principal of these comprise an Anomurid, a Porcelain-crab and, most interesting of all, a tiny Gobioid fish of an hitherto undescribed species of the genus *Pleurosicya*.

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* "The Alcyonaria of the Maldives" in *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, Vol. II, Pt. II, Cambridge, 1903.

The Alpheid, which clicks loudly when disturbed, is pale in colour and lives Diogenes-like in the tubular portions of the host, which are usually white-walled within, so that the colourless alpheid is indistinguishable when lying in wait in his lair for any small animals that may be tempted to enter for shelter. The little fish also uses the tubular region as a permanent home. In colour it is suffused pink over the whole body. It appears to lead a much freer life than its companion, the Alpheid, issuing forth to search for food frequently, but ready to retreat to his burrow on the least sign of danger.

The other two of the usual commensals living with *Solenocaulon*, do not seem to make any particular use of the hollow and grooved branches though doubtless they do derive some protective benefit from these facilities for hiding. They are however generally found crawling over the branchlets and among the polyps with which their colour assimilates perfectly.

Hickson suggests that grooving and tubulation are due to the irritation of the tissues consequent upon the constant running to and fro of the Alpheid. I am inclined to think that the irritation is more direct and specific ; whether the nippers of the big chela have anything to do with it, say by pinching, is worth consideration when some one with the needful opportunity turns attention to this problem.

Commensals of Gorgonids.—Gorgonids of many species are abundant on rocky and stony ground everywhere in shallow water round the Indian

Fig. 1.—Wing-shells (*Avicula radiata*) commensal with a sea-fan. (Original).

coasts. In the Gulf of Mannar on rough bottom these sea-fans and sea-whips are particularly characteristic. Unlike Spongodes their surface texture is hard and coriaceous, and as their branching is usually in one plane, they do not afford such excellent hiding places to those small animals that elect to live as commensals. But as they are well defended from attack by their hardness and spicular texture, a number of animals nevertheless do seek protection by association with them. These are much better known to zoologists than those of Spongodes and Solenocaulon; it has long been noted, for instance by Thurston*, that delicate Ophiuroids commonly cling in numbers to the branches of the larger Gorgonids, while the beautiful little Cypræid, *Ovula* (*Radius*) *formosa*, is sometimes found crawling along the branches and mimicing their colour exactly, whether red or yellowish-brown. Aviculids (*A. radiata*) have also been noted, settled on several species of sea-fans, their narrow elongated shells oriented in such way that, at least when young, they blend in shape with the branches and so escape detection; they usually settle on colonies of brownish tint similar to their own. (Fig. 1.)

All these I have frequently met with on Gorgonids on both sides of the Gulf of Mannar, together with several other less common or conspicuous commensals. Tiny Ophiuroids are by far the most plentiful. On one great specimen of *Leptogorgia australiensis* having a spread of 6¾ in. in height by 11 inches in width, I counted 952 individuals, and on two smaller ones from the same locality (north end of the Periya Pār, Ceylon), 159 and 109 were noted respectively. I had understood from previous writers that these Ophiuroids followed the common commensal rule of assimilating in colour to that of their host. My actual experience showed a noteworthy discrepancy. Taking the three specimens above noted, all of dark claret colour, two colour varieties of the ophiuroid were represented, one claret-coloured, the other orange. The former however predominated; of the 952 on the largest Gorgonid, 622 were of this hue, while 330 only were orange; upon the second, 85 were claret, 74 orange, while those on the third were divided into 69 claret and 40 orange. All the Gorgonid trees taken at this particular place were claret coloured. On another occasion, on the outer Vangali Pār (Ceylon) in depths of 7¼ to 9 fathoms, the same species was found in remarkable abundance, over 250 colonies being obtained in one morning; the great majority were claret coloured as in the previous case but a few were orange-coloured. All colonies, irrespective of colour, were infested heavily with the same little Ophiotrix which again showed the same two colour varieties. Whether on the orange or the claret coloured Gorgonids, the majority of the ophiuroids were of the latter colour. Correlated with this we must note that by far the greater number of this Gorgonid (*Leptogorgia australensis*) are claret coloured; only a small minority are orange. But the same ophiuroid is also found on other species and on none more commonly than on *Lophogorgia lutkeni*. Now this species is characteristically and consistently orange in colour and wherever I have found it bearing these ophiuroid commensals, the latter have all been of the yellow variety. The occurrence of the yellow form only on the orange coloured *Lophogorgia lutkeni*, whereas both colour varieties are found commingled on *Leptogorgia australiensis*, which is predominently claret coloured and only rarely yellow, suggests that the yellow variety is the original colour of the Ophiuroid and that the claret coloured ones represent a variety in process of colour evolution with a view to adaptation to the tint of the claret-hued (and predominant) variety of *L. australiensis*. The colour has not yet become stabilized, seeing that a large proportion, roughly 35 per cent., are still yellow among those seen on the Gorgonids of claret tint. As the orange

* Thurston E. "Littoral Fauna of the Gulf of Manaar", *Madras Government Museum Bulletin*, No. 3, Madras, 1895, page 104.

ophiuroids are extremely conspicuous on such hosts, these must tend to be picked off by those animals that feed upon them; this must give such an advantage to those strains that produce a majority of dark coloured offspring that there can be little doubt that here we have a distinct variety in the making, whereby a strain will be formed producing none but dark coloured young to live on a similarly coloured host.

Masking among Indian Crabs.

The habit of certain crabs to seek safety by masking their body with weeds and sponges and other organisms is well known; the spider-crabs of the family Maiidæ, the velvet crabs (Dromiidæ), and the various species of the sand-crab *Dorippe*, are those that have developed this habit to its greatest extent. They adopt two principal methods; the first, employed by the spider-crabs, is by trimming the carapace and often the larger legs, with fragments of seaweeds, sponges, zoophytes or ascidians, which are held in position by being hooked on recurved hairs developed for this purpose, and not found on any other kind of crab. The surface of the carapace in these crabs is very rough, usually raised into numerous low conical tubercles; these assist in heightening the disguise and in one case, where I had a number of the large English *Maia squinado* in confinement (Jersey) in a tank bereft of seaweeds, the crabs in lieu of anything better adapted to the purpose, selected suitable pebbles and balanced them carefully among these tubercles. The second method, that of the various genera of the Dromiidæ and Dorippidæ, is to hold either a mass of some unattractive sessile animal or a flattened shell over the back as a concealing cloak; to this end the hinder legs, either one or two pairs, are employed, and specially modified both in jointing and in the form of the terminal joint. This last in these crabs is sharp and exactly suits its purpose of being hooked into the substance of the concealing sponge or ascidian in the case of the Dromiidæ; in the Dorippidæ the two last joints are still further modified so that they form a fairly perfect hook, peculiarly well adapted to grasp the thin edge of a shell held aloft over the body. (Figs. 2 and 5).

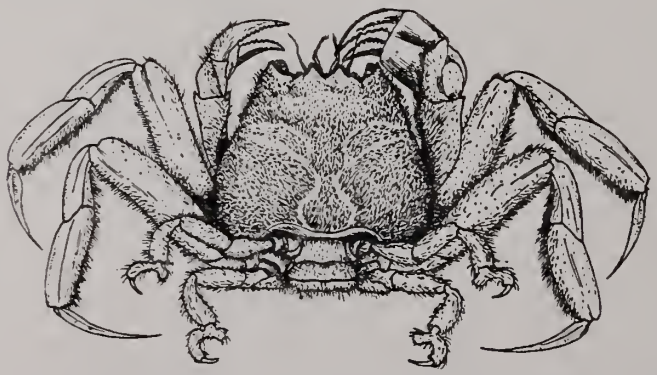

Fig. 2.—*Dorippe facchino* stripped of its masking organism, to show the two pairs of specialized thoracic limbs with their terminal hooked joints. (Original.)

In the weedy shallows of Palk Bay, a small stoutly built spider-crab, *Halimus* sp., is fairly common. After the manner of its kind it usually decorates its

shell with fragments of seaweed, but occasionally I have met with individuals that have improved on this, by camouflaging the carapace and limbs with many worm-like Synaptids, striped very distinctively purple and white (*Synapta striata*). These live normally as commensals with certain rough-surfaced sponges ; it is evident that the crab picks these off the sponge and transfers them to its own back and limbs. (Fig. 3.) The drawing given has been made from a preserved

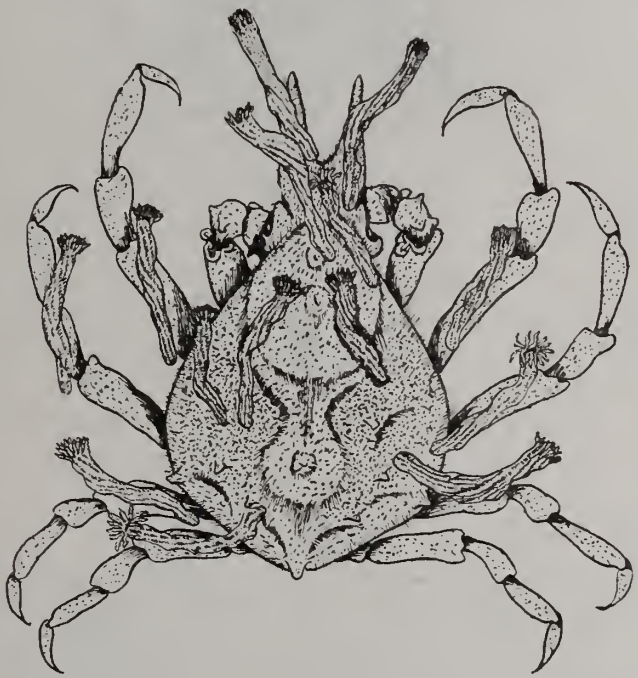

Fig 3.—A Spider-crab (*Halimus*) from Palk Bay that has decorated its carapace and limbs with striped Synaptids for protection. (Original.)

specimen, after several synaptæ had been removed, but even so, it shows how symmetrically the synaptæ are arranged, and particularly the way in which each leg of the crab has its own synapta, arranged so as to conceal it effectually. In addition to concealing the crab, the synaptæ give it protection through their warning colouration ; their skin is full of tiny calcareous spicules of which many are in the form of 'anchors', the points (flukes) projecting, so that if touched the synapta adheres like a burr and is not easily shaken off.

Except in regard to the association of one species of Dromia with Spongodes as above detailed, I have little to add to what is known of the masking habits of the velvet-crabs. Most usually a massive silicious sponge is used to hide the body, as shown in figure 4. In this case the sponge has been so long held in position, that its growth has gone on to such an extent that it fits the body of the crab like a glove, indeed the crab appears to be occupying merely a cavity scooped out in the underside of a massive ball of sponge. Less frequently an ascidian colony is utilized and on one occasion I noted that the concealing cloak carried by a tiny Dromia, only a quarter of an inch across the carapace,

was a ramifying mass of the fine branches of the calcareous sponge *Leucosolenia* greenish yellow in colour.

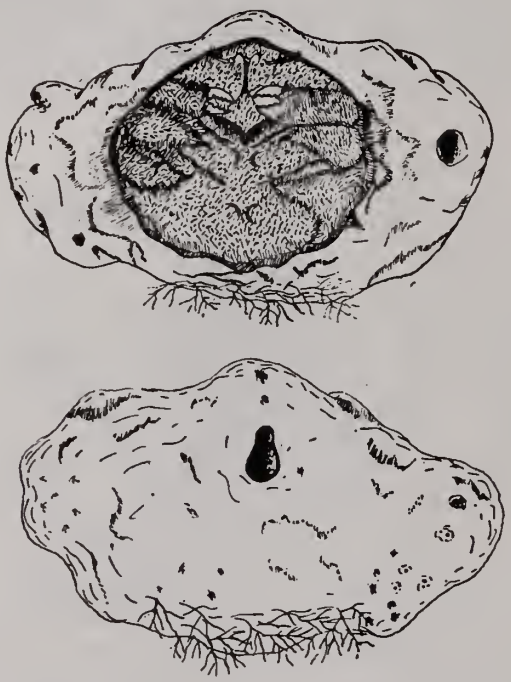

Fig. 4.—A Velvet-crab (*Dromia* sp.) under the mask of a stout silicious sponge. The lower figure depicts, the sponge mantle entirely hiding the crab from view the upper one shows the under side of the pair, the crab ensconced in a deep hollow in the mass of the sponge. (Original).

At least two species of *Dorippe* are common on the Madras east coast,

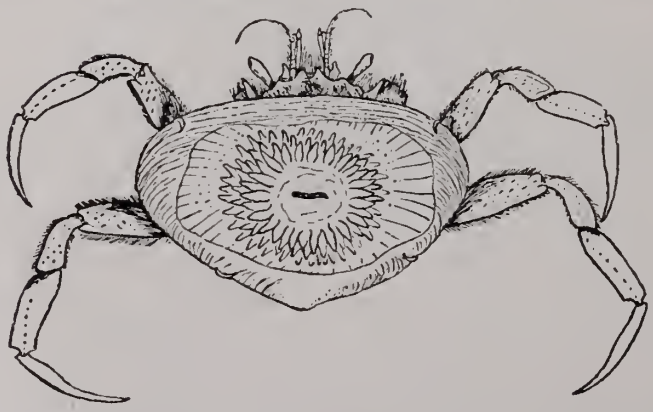

Fig. 5.—*Dorippe dorsipes*, carrying an anemone seated upon a shell. (Original).

D. dorsipes and *D. facchino* (Fig. 2). Both love sandy bottom, and *Dorippe dorsipes* is particularly numerous at Madras; numbers are often to be found in the rubbish thrown aside from fishermen's nets. Their usual habit here is to carry over their back a valve of some species of thin bivalve shell, concave side down, of size suitable for effective concealment. The illustration given (Fig. 5) shows the usual appearance of this crab when carrying his buckler in position, held securely by the claws of the two last pairs of legs; the points of these claws show over the edge on both the fore and hinder margins of the shell. In many cases, the defence is increased by the presence on the surface of the shell of a little pale-coloured anemone. Just as the association of *Synapta striata* with the spider-crab already noted, gives added protection because of the burr-like spicules in the skin of the synapta, so here the crab, perching an anemone upon the concealing shell, provides himself with a whole series of ready-made batteries of stinging cells, capable of frightening away any small fishes that might otherwise penetrate the disguise of the concealing shell. Hermit-crabs are known to transfer the anemone *Adamsia* from other gastropod shells to those which they use for their own habitation, so here it seems certain that *Dorippe* has a related habit, but whether it merely selects a shell on which an anemone already is settled, or whether it actually detaches the anemone from its first foothold and then transfers it to the shell which it has already selected for its concealing cloak is not known. This is one of those interesting points that can only be settled by keeping these animals under close observation in an Aquarium

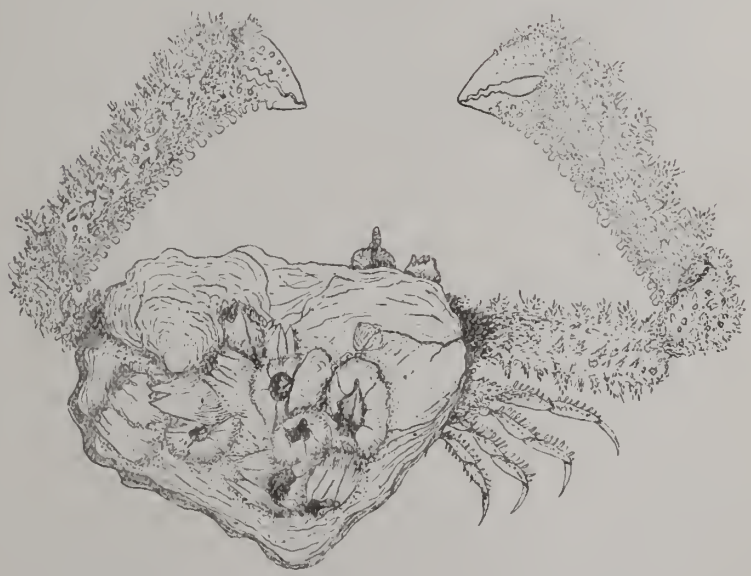

Fig. 6.—*Lambrus*, a crab that lives on shingly bottom; the carapace in this case is concealed by a mask of oyster shells and barnacles. (Original).

Figure 6 shows a form of masking brought about, not by deliberate action on the part of the crab, but through its pure passivity and slowness of movement. It is a *Lambrus*, whereon an oyster (*Ostrea* sp.) has settled, and grown so as to cover the whole of the carapace and the legs on the left side. This crab lives on pebbly bottom and when at rest with the chelipeds folded close to the body and the other legs tucked down, such an individual as this would look a worthless morsel to tackle. The association is of long standing, for on the original oyster two younger ones have settled, together with over a dozen barnacles (*Balanus*). *Lambrus* like *Calappa* shams death, when disturbed.